Forest waste biomass valorisation: Effect of mixed materials and operational management in the compost quality

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ABSCTRACT

In Portugal, the number of fires and the size of burnt areas are rising dramatically every year. The fire risk increased with improper management of forest waste. This study shows a comparison between 3 composting processes performed with residual biomass, following two different monitorization approaches. The agro-forest residues (AFRs) from the Residual Biomass Collection Centre (RBCC) in Bodiosa (Viseu, Portugal) were used and are mostly characterised by forest, agricultural and pruning residues. Sewage Sludges from an urban wastewater treatment plant were used as conditioning agent in one of the piles. Two of the processes – one only with AFRs (MC) and other with a mix of AFR and Sewage Sludges (MCS) were managed according with good practices, periodic aeration and water addition if required. The third pile was carried out only with the AFRs collected at the RBCC, without any monitoring or water addition (NMC). The purpose of this pile was to assess the compost quality of a non-monitored pile to evaluate this option for local farmers to produce compost on their own land, with a minimal cost. Periodic monitoring and sampling of MC and MCS were carried out to assess their evolution, measuring the piles temperature, pH, electric conductivity and moisture. At the end of composting period (day 120), it was assessed the compost quality. The temperature evolution of the composting process was the expected for both piles. The final composts from the 2 monitored piles (MC and MCS) were similar. However, the compost from the MNC pile, with no operational intervention, showed a higher germination index.

INTRODUCTION

Da Costa *et al.* (2020) shows that the Portuguese territory occupies a strategic position for forest growth, covering about 35% of the territory to date. However, the number of fires and the size of burnt areas are rising dramatically every year. A direct consequence of the increase in forest fires is the deterioration in the quality of the burnt soils. From the forest area, only 3% is owned by the State, 12% is ownerless, so 85% of forest areas, with an average size of 5 ha, belong to about half a million owners, often of advanced age, also considering the aging trend of population in rural areas (Gomes, 2006). As a result of this situation, it is difficult to implement consistent and effective agro-forestry residues (AFRs) management practices to reduce the fire risks.

In this scenario, to improve the AFRs management, a Residual Biomass Collection Centres (RBCC) were implemented, proposing themselves as public sites where all the citizens can discharge the residual biomass waste from their forest areas, and the green biowastes from the gardens.

At this moment, the wastes from this RBCC are valorised for energy production. However, the valorisation of AFRs through composting to produce an organic soil amendment to improve the burned soils quality, reducing the use of chemical fertilizer is needed. This eco-sustainable AFRs valorisation process is still not very widespread in Portugal: few studies were carried out in literature with practical application and generally these studies deal with urban or agricultural wastes composting.

Thus, this study shows a comparison between three composting processes performed with a residual biomass from RBCC, following two different approaches. Two piles were operational monitored and intervened and one pile had no intervention during the composting period. The purpose of this last pile was to assess the compost quality of a not monitoring composting to evaluate the option for local farmers to produce compost on their own land, with a minimal cost.

METHODOLOGY

To fulfil the work purpose, 3 cone-shaped composting piles (2 m base diameter and 1.2–1.5 m height) were prepared. In 2 of these piles only AFRs were used (MC and NMC) while in the third ones (MCS), a mix of biomass from RBCC and sewage sludges were used as conditioning agent. NMC was performed with no intervention during the composting period. On the other hand, MC and MCS piles were monitored, and watering and aeration procedures were accomplished to assure the optimum conditions for the biochemical process. AFRs used were previously reduced in size. The management of MC and MCS piles were done by daily measuring of the temperature, every week moisture, electrical conductivity (EC), pH, total organic matter (TOM), ashes, total organic carbon (TOC) and total nitrogen (TN) were measured. Moisture content was adjusted whenever it was lower than 45%. When temperature decreased to T_{amb}, the previous mentioned parameters were evaluated monthly. The process was finished at 120 days. To determine the composts quality, physical, chemical and biological analyses were carried out as indicated in the Ordinance nº185/2022.

RESULTS

The Figure 1 shows the temperature profile of the 2 monitored piles. MC compost reaches a maximum temperature of 57.7ºC on the 7th day of composting, indeed in the early stage of the process there is a rapid reduction of TOM (Figure 1b). A further peak of 54.8ºC is reached after 21 days of composting. After 40 days of composting, the average temperature of the piles were around ambient temperature (T_{amb}).

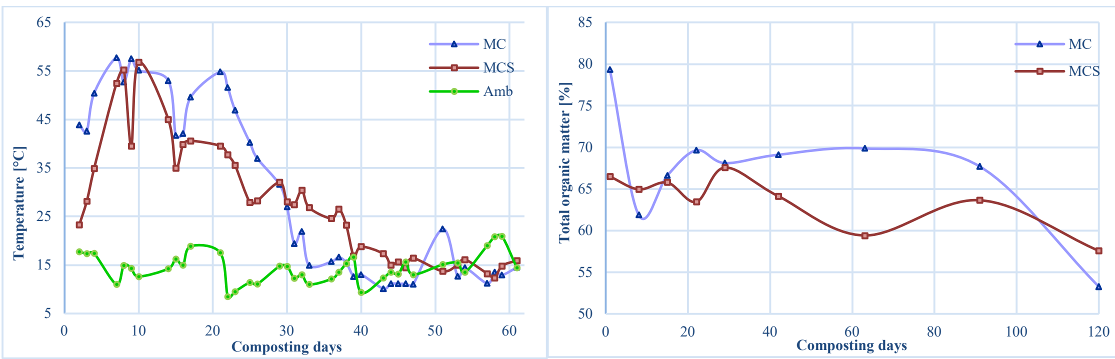

Figure 1. Evolution of the composting processes: a) temperature profile; b) TOM evolution.

Table 1 shows the physical, chemical and biological parameters of the composts under analysis. The 2 monitored piles (MC and MCS) produced composts with similar quality, considering the TOM, ashes and TOC. Moreover, they showed the lowest C/N ratio. GI reaches considerably high values, notably for the NMC compost. It seems that the needed of intervention is not very important for these types of wastes.

Table 1. Composts characterization

Parameters	**Compost**		
	NMC	**MC**	**MCS**
Moisture [%]	60.83±0.26	57.21±1.14	61.77±0.16
TOM [$\%_{dry\ mass}$]	77.74±3.59	53.27±2.20	57.60±1.18
Ashes [$\%_{dry\ mass}$]	22.26±3.59	46.73±2.20	42.40±1.18
TOC [$\%_{dry\ mass}$]	43.19±1.99	29.59±1.22	32.00±0.66
Density [g/cm^3]	0.44	0.40	0.46
pH	7.92±0.03	7.97±0.02	5.78±0.02
EC [µS/cm]	369.70±16.57	401.33±4.32	444.11±4.96
TN [$\%_{dry\ mass}$]	1.00±0.01	1.02±0.02	1.74±0.03
NO_3^-- N[g/$kg_{dry\ mass}$]	12.85±0.38	16.78±1.16	76.79±0.71
C/N	43.18	28.96	18.43
Germination Index (GI) [%]	146.80	54.50	77.20
Stability class	V	V	V

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